January 1996

Science 30

Grade 12 Diploma Examination

Alberta
EDUCATION

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Science 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar will be used to indicate the end of a set.

A science data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. science
B. biology
C. physics
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

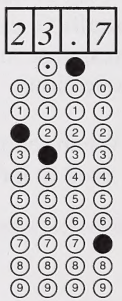
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

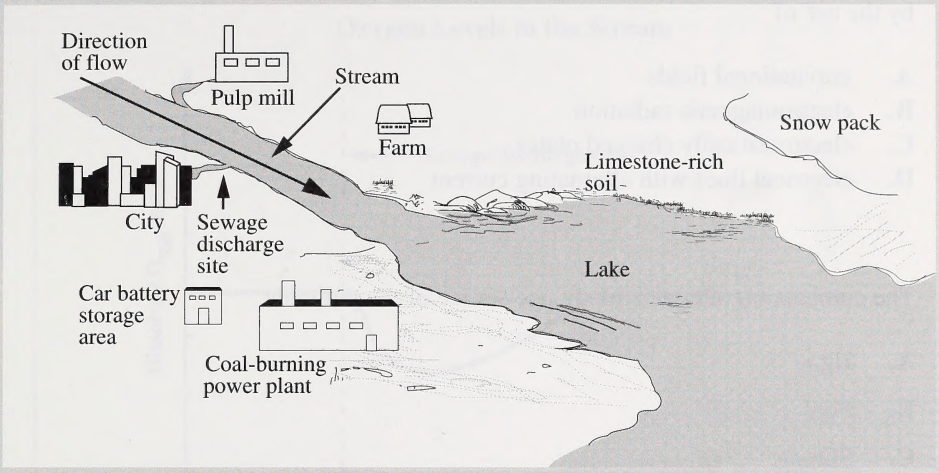
Record 3214 on the answer sheet →

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

Do not turn the page to start the examination until told to do so by the presiding examiner.

An environmental technician conducted a study in the area shown in the diagram.



Numerical Response

1. The technician collected a sample of snow and determined the pH to be 5.50. The hydronium ion concentration $[H_3O^+_{(aq)}]$ of this sample was _____ $\times 10^{-6}$ mol/L.

(Round and record your answer to two digits on the answer sheet.)

1. There is an abundance of limestone in the soil around the lake. Water (pH of 5.50) from the melting snow pack runs into the lake. A reasonable hypothesis concerning the effect of the soil on the pH of the water is that the pH of the water

A. entering the lake will be lower than the pH of the snow pack because limestone is basic

B. entering the lake will be higher than the pH of the snow pack because limestone is basic

C. entering the lake will be the same as the pH of the snow pack because limestone is a buffer

D. in the centre of the lake will be the same as the pH of the snow pack because limestone is a buffer

2. Smoke and soot particles pick up positive and negative charges. These particles could be filtered from the exhaust gases leaving the chimney of the power plant by the use of

A. gravitational fields
B. electromagnetic radiation
C. electrostatically charged plates
D. electrical lines with alternating current

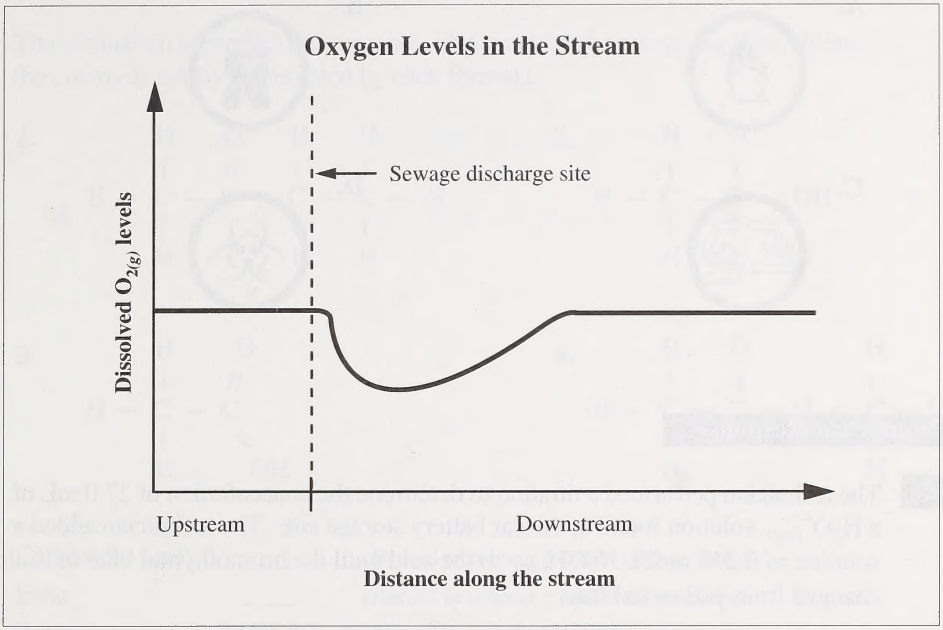
3. The combustion of coal is likely one source of the pollutant

A. $Hg_{(l)}$
B. $Pb_{(s)}$
C. $SO_{3(g)}$
D. $ClO_{(g)}$

4. A reasonable prediction about dioxin levels and organisms in the lake is that the concentration of dioxin will be greater in the

A. water than in the trout
B. trout than in the minnows
C. minnows than in the trout
D. algae than in the minnows

Use the following information to answer the next question.



5. The technician tested the dissolved oxygen levels along the stream that flows into the lake. A reasonable hypothesis related to the graph is that the concentration of oxygen dropped because the

A. discharged sewage displaced oxygen

B. bacteria that decompose sewage require oxygen

C. sewage underwent buffering, which used the oxygen

D. temperature dropped near the sewage discharge site and decreased the solubility of oxygen

6. On a sign at the car battery storage site, the technician saw the symbol

A.

B.

C.

D.

Numerical Response

2. The technician performed a titration to determine the concentration of 27.0 mL of a $H_3O^+_{(aq)}$ solution found at the car battery storage site. The technician added a solution of 0.240 mol/L $NaOH_{(aq)}$ to the acid until the bromothymol blue indicator changed from yellow to blue.

Initial volume of base	=	25.80 mL
Final volume of base	=	7.80 mL

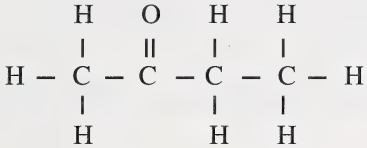
The data from the experiment indicate that the concentration of the H_3O^+ was _____ mol/L.

(Round and record your answer to three digits on the answer sheet.)

Numerical Response

3. The technician identified four organic substances from various test sites. Identify the chemical family represented by each formula.

1.



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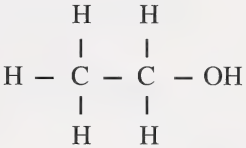

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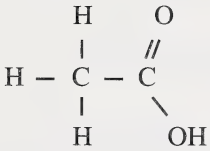

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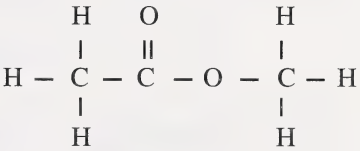


Carboxylic acid _____ (Record in column 1 on the answer sheet.)

Ester _____ (Record in column 2 on the answer sheet.)

Ketone _____ (Record in column 3 on the answer sheet.)

Alcohol _____ (Record in column 4 on the answer sheet.)

7. Over time, dripping water from the roof of the coal-burning power plant caused pitting in a marble plaque attached to the wall of the power plant. The reaction that produced the chemical most likely responsible for this corrosion is

A. $SO_{2(aq)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$

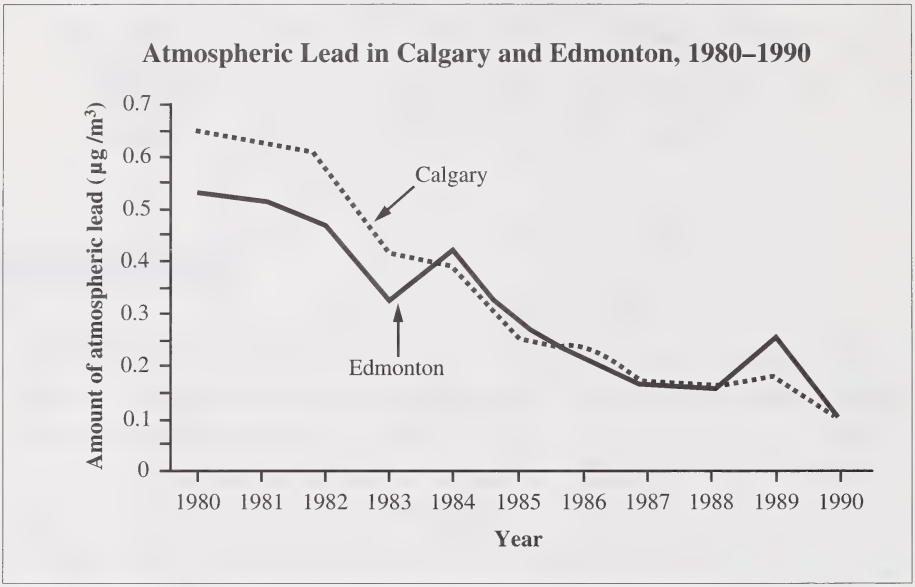
B. $CaCO_{3(s)} + \text{heat} \rightarrow CaO_{(s)} + CO_{2(g)}$

C. $2\ NH_{3(g)} + H_2SO_{4(aq)} \rightarrow (NH_4)_2SO_{4(s)}$

D. $CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

In recent years, environmental issues have become important.

Use the following information to answer the next question.



8. Which is the most likely explanation for the trend shown in the graph?

A. The use of leaded gasoline declined significantly during the 1980s.

B. Traffic density in urban areas decreased significantly during the 1980s.

C. Public transit systems became less extensive in both cities during the 1980s.

D. Patterns of air circulation changed due to the construction of tall buildings in both cities during the 1980s.

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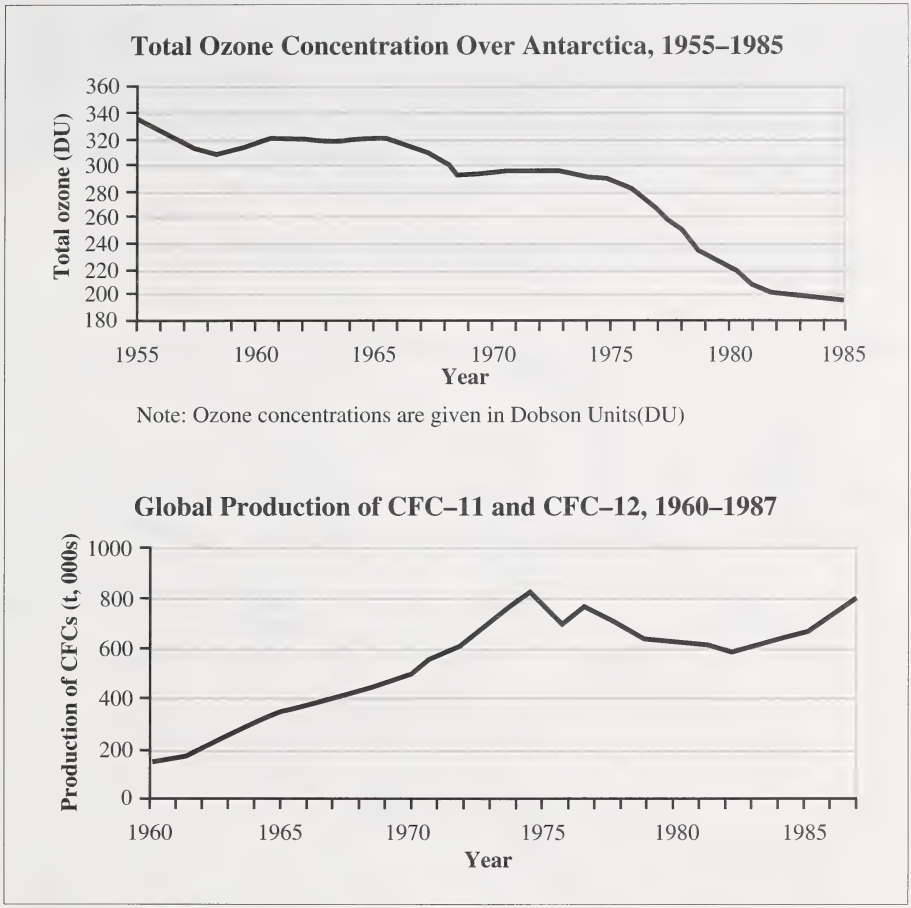
9. The largest source of nitrogen dioxide in urban areas is

A. combustion of ammonia
B. internal combustion engines
C. decomposition of organic matter
D. effluent released from water treatment plants

Use the following information to answer the next question.



10. A valid interpretation regarding the relationship between the general trends shown in the graphs is that

A. as CFC production increased, the concentration of ozone over Antarctica decreased

B. as CFC production increased, the concentration of ozone over Antarctica increased

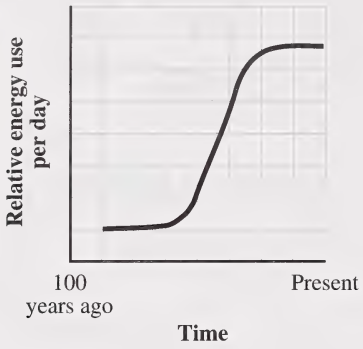
C. the production of ozone is unrelated to the concentration of CFCs over Antarctica

D. as CFC production declined from the mid-seventies to the early eighties, the concentration of ozone over Antarctica increased

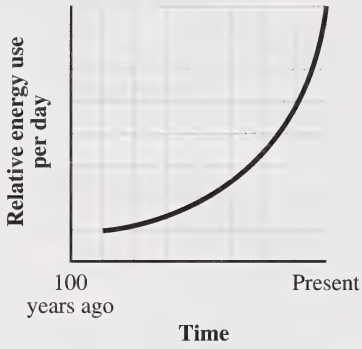
Canada is endowed with a wide range of energy resources. Directly or indirectly, Canadians consume more energy per day per capita than the citizens of any other country.

11. Which graph **best** illustrates energy consumption by humans over the last hundred years?

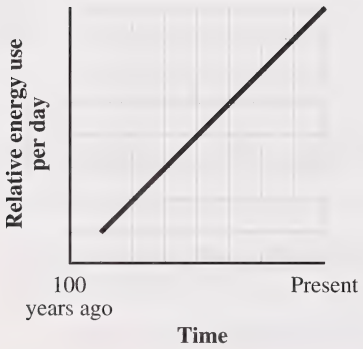
A.



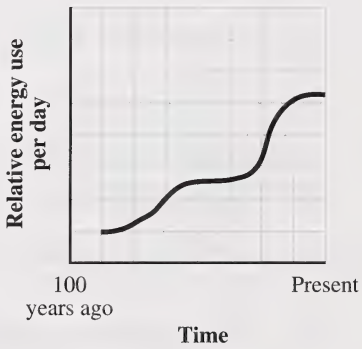
B.



C.



D.



12. The CANDU nuclear reactor, which is manufactured in Canada, provides electrical power through nuclear fission. The difference between nuclear fission and nuclear fusion is that

A. fission involves splitting of atomic nuclei, while fusion involves joining of atomic nuclei

B. fusion involves splitting of atomic nuclei, while fission involves joining of atomic nuclei

C. fission releases energy from atomic nuclei, whereas fusion absorbs energy into atomic nuclei

D. fusion releases energy from atomic nuclei, whereas fission absorbs energy into atomic nuclei

13. Which equation represents a balanced reaction that takes place in a nuclear fission reactor?

A. $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He}$

B. $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

C. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}$

D. $^{235}_{92}\mathrm{U} + {}^{1}_{1}\mathrm{p} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{1}\mathrm{p}$

Use the following information to answer the next three questions.

Possible Energy Sources

I	coal
II	nuclear
III	solar
IV	wind
V	hydro
VI	tidal

14. Energy sources resulting directly or indirectly from solar radiation are

A. I and III only
B. I, III, and V only
C. I, III, IV, and V only
D. I, II, III, IV, and V only

15. The energy sources that have limited usefulness because their availability is **unpredictable** on a day-to-day basis are

A. I and II only
B. III and IV only
C. III and V only
D. V and VI only

16. Which of the energy sources relies on gravitational fields?

A. IV only
B. V only
C. IV and V only
D. IV, V, and VI

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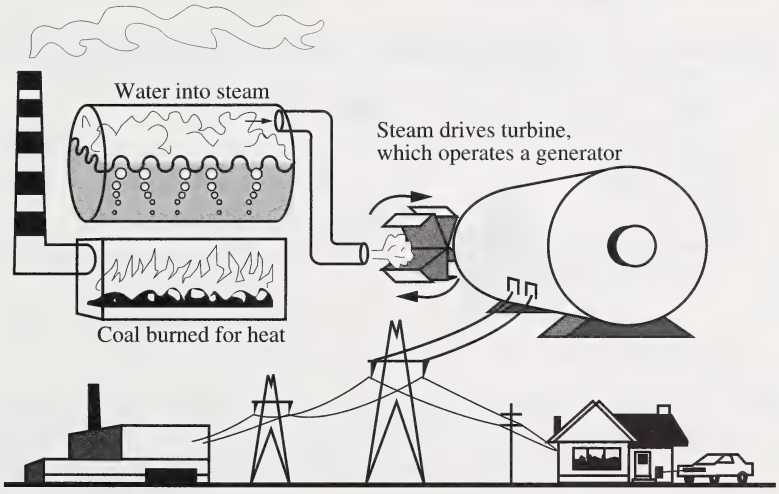
17. Which statement about tidal energy is **true**?

A. Using tidal energy results in lower tides.
B. An eclipse of the Sun can cause tidal waves.
C. Tidal energy contributes to the melting of the polar ice caps.
D. The Moon's phases have a relationship to the height of tides.

Perhaps the most convenient form of energy for domestic use is electrical energy. Power grids in different regions supply Canadians with this form of energy.

Use the following information to answer the next question.

Production of Electricity from Coal



Electricity transmitted along towers and delivered to homes and industry

Numerical Response

4. Provide the sequence of energy forms that occur when coal is burned to produce electricity.

1	mechanical	**3**	chemical
2	electrical	**4**	thermal (heat)

Answer: _____ to _____ to _____ to _____

(Record all four digits on the answer sheet.)

Use the following information to answer the next question.

Fields Found in a Power Plant

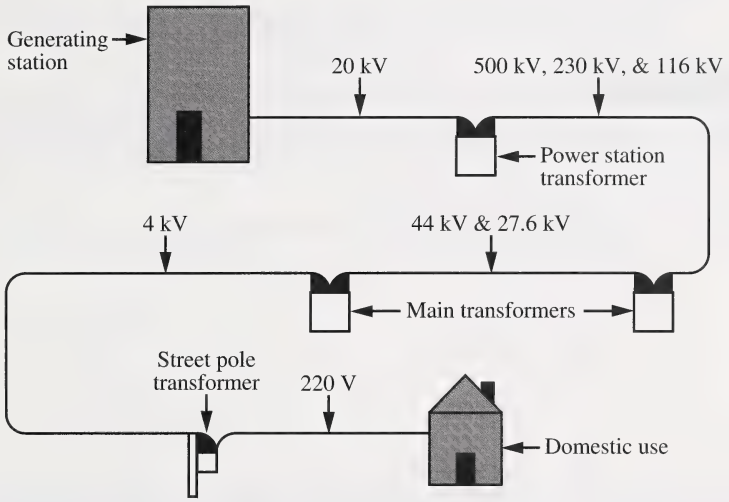
I electric
II magnetic
III gravitational
IV light

18. Voltmeters, ammeters, electrical motors, and electrical generators are used in power plants. These devices use fields

A. I and II only
B. I and III only
C. II and IV only
D. III and IV only

Use the following information to answer the next question.

This diagram shows how the voltage produced by a generating station is modified as it is transmitted to the end user.



19. The electricity leaving a generating station passes through a number of transformers on its way to the consumer. At one of the power station transformers, the voltage increases from 20 kV to 500 kV. The voltage is stepped up because

A. more thermal energy can be produced at the higher voltage

B. high-voltage electricity travels faster than low-voltage electricity

C. less electrical energy will be lost at high voltage than at low voltage

D. the resistance of the wire has a greater effect on the current at high voltage than at low voltage

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Numerical Response

5. In order to distribute the electricity produced by a power station, electricity from a 240 V generator passes through a step-up transformer with a 155-turn primary coil and a 75 000-turn secondary coil. The voltage produced by this transformer is _____ $\times 10^5$ V.

(Round and record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

A consumer leaves a 100 W porch light on for several days. The 100 W bulb consumes 2.4 kW•h of energy each day. It takes 1.0 kg of coal to produce 2.0 kW•h of electricity.

Numerical Response

6. How many kilograms of coal will be consumed to power the light bulb for five days?
Answer: _____ kg

(Round and record your answer to two digits on the answer sheet.)

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20. The light from a fluorescent porch light was analyzed using a spectroscope and found to produce a bright-line spectrum. From the spectrum, it would be possible to analyze the

A. gas in the bulb
B. amount of red shift
C. efficiency of the bulb
D. polarization of the light

21. A consumer would know that the bulbs in a single set of Christmas tree lights are wired in parallel if the

A. plug-in at the end of the string has three prongs
B. remaining lights stay on when one light burns out
C. remaining bulbs get dimmer when some bulbs burn out
D. bulbs become dimmer when more bulbs are added to the string

A doctor deals with a number of patients each day.

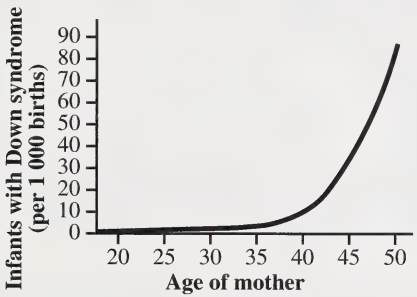
Use the following information to answer the next question.

Down syndrome is a genetic disease. Its incidence in infants is related to the age of the parents. A 35-year-old woman was considering having a child. The doctor showed the woman the following data.

Age of mother (years)	Probability of having an infant with Down syndrome
20	1 in 1 925
25	1 in 1 205
30	1 in 855
35	1 in 365
40	1 in 110
45	1 in 32
50	1 in 12

22. The graph that correctly shows this data is

A.



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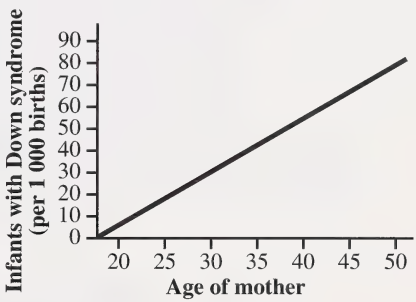
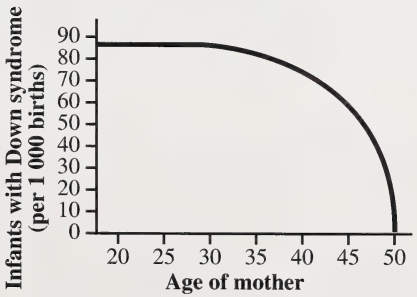
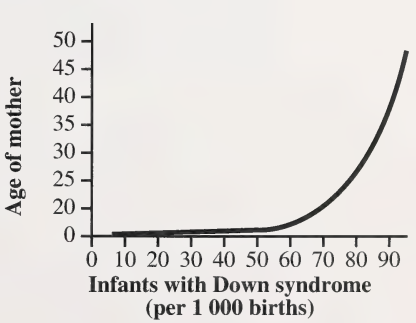


C.



D.



23. The term phenotype refers to the

A. segregation of chromosomes
B. gene make-up of an organism
C. alternate forms of the same gene
D. physical characteristics of an organism

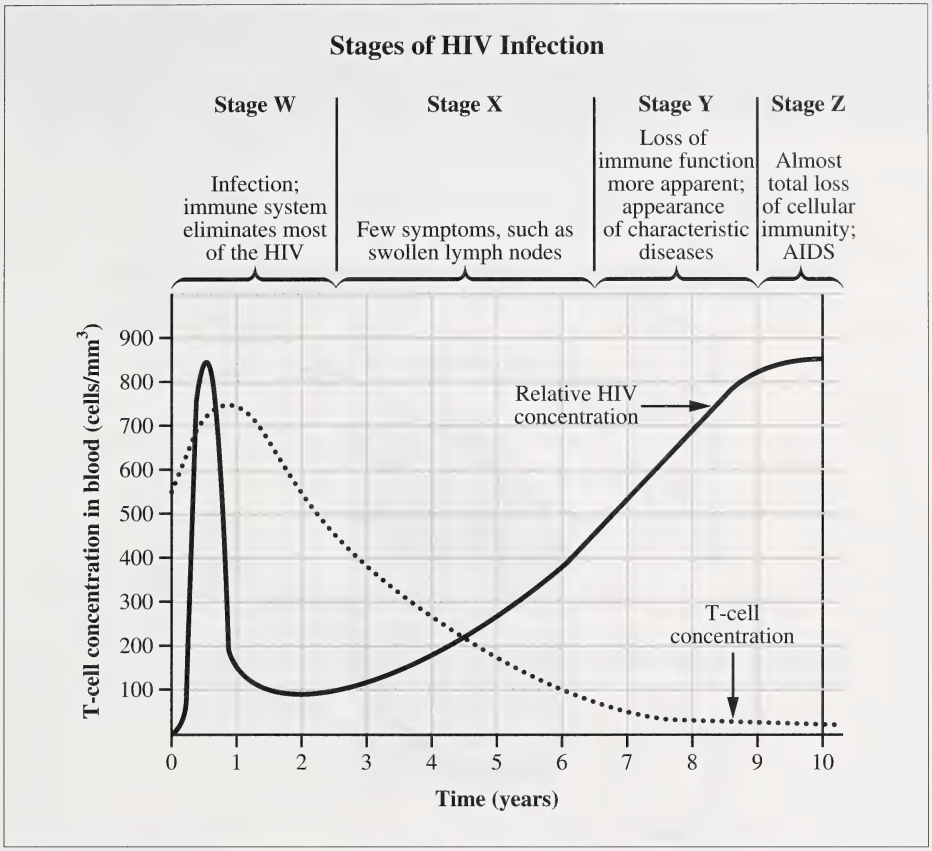
24. A child with Down syndrome often has blue lips and fingernails. A likely cause of this condition is

A. excess $O_{2(g)}$ in the blood
B. lack of $O_{2(g)}$ in the blood
C. excess $CO_{2(g)}$ in the blood
D. lack of $CO_{2(g)}$ in the blood

25. Another patient asked her doctor about the possibility of her unborn son inheriting colour-blindness from his father. In X-linked (sex-linked) conditions, male offspring do not inherit the father's defective gene because sons receive the

A. X chromosome from their father
B. X chromosome from their mother
C. Y chromosome from their mother
D. X chromosome from either parent

Use the following information to answer the next question.



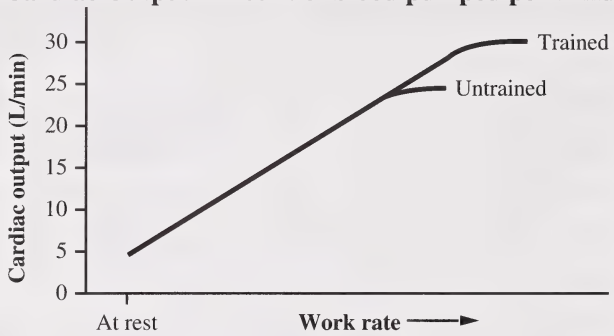
26. The doctor explained the usual progression of HIV infection to a patient. What is the conventional explanation for the relationship between T-cell concentration and HIV concentration in **stage Y** of the infection?

A. Increased T-cell concentration causes HIV concentration to increase
B. Increased HIV concentration causes T-cell concentration to increase
C. Increased T-cell concentration causes HIV concentration to decrease
D. Increased HIV concentration causes T-cell concentration to decrease

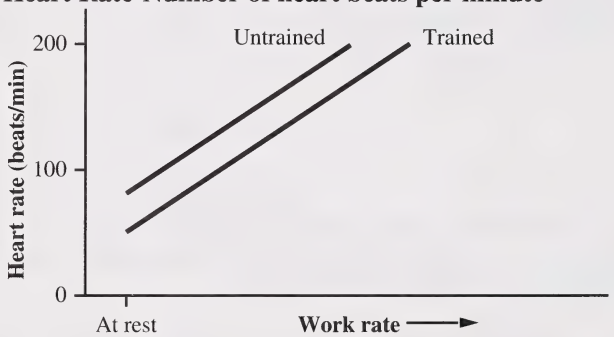
An athlete participating in a rigorous physical training program was provided with data related to the circulatory system.

Use the following information to answer the next question.

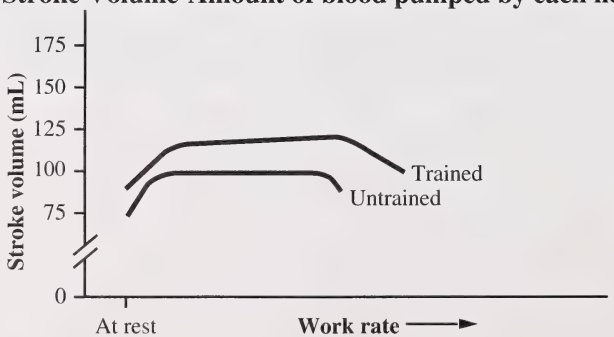
Graph 1: Cardiac Output-Amount of blood pumped per minute



Graph 2: Heart Rate-Number of heart beats per minute



Graph 3: Stroke Volume-Amount of blood pumped by each heart beat

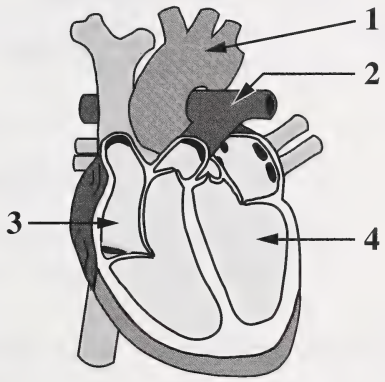


27. The graphs indicate that after physical training a person's heart

A. can beat faster without damage
B. will produce a lower cardiac output
C. can produce a higher cardiac output while at rest
D. will pump a greater volume of blood with each beat

Use the following information to answer the next question.

The Human Heart



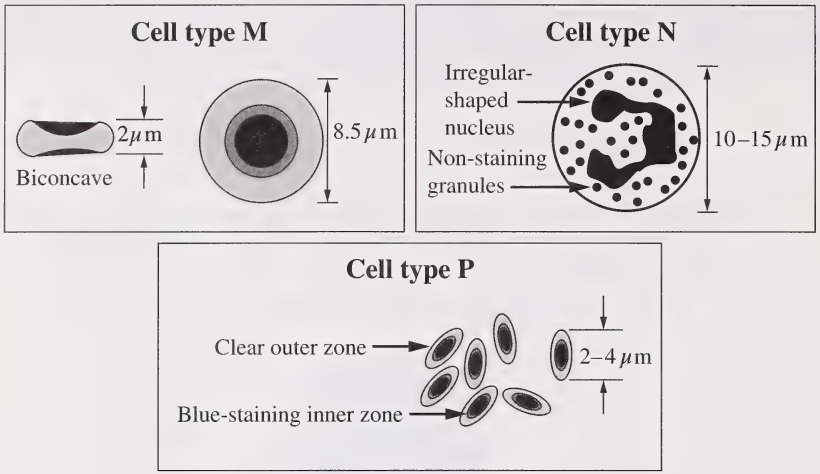
Numerical Response

7. The pathway followed by a red blood cell as it travels from the vena cava to the aorta is _____ , _____ , _____ , _____ .

(Record all four digits on the answer sheet.)

Use the following information to answer the next two questions.

Blood Components



	Cell Type M	Cell Type N	Cell Type P
Function	transport of oxygen and carbon dioxide	phagocytosis	blood clotting
Number in each cm^3 of blood	4 000 000	6 000	500 000
Condition associated with lack or excess of cell type	Anemia	Leukemia	Hemophilia

28. The correct names for cell types **M**, **N**, and **P**, respectively, are

A. red blood cell, white blood cell, and platelet
B. platelet, red blood cell, and white blood cell
C. red blood cell, platelet, and white blood cell
D. platelet, white blood cell, and red blood cell

29. The athlete complained of dizziness while exercising. Symptoms of dizziness would most likely be caused by insufficient numbers of cell

A. type N only
B. type M only
C. types N and P
D. types M and N

A group of friends planned a camping trip in the mountains. They anticipated potential hazards and packed equipment essential for their safety.

30. Most of the campers drove to the mountains in a gasoline-powered van, but one person decided to ride a bike. The organic compounds that are a source of energy for a person's body and for the van, respectively, are

A. glucose and octane
B. glucose and butane
C. octane and methane
D. sucrose and glucose

31. The correct formula and group name for a commonly available **alternative** fuel for the van is

A. CH_3CH_2OH (ketone)

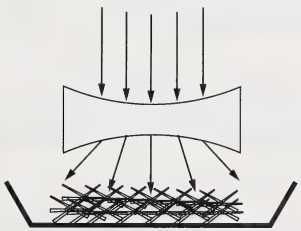
B. CH_3CH_2OH (alcohol)

C. $CH_3COCH_2CH_3$ (alcohol)

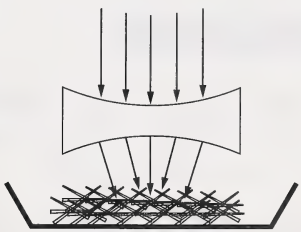
D. $CH_3CH_2CH_2CHO$ (ketone)

32. The campers used a pocket lens to start a campfire. Which diagram correctly represents this procedure?

A.



B.



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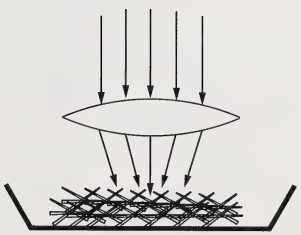

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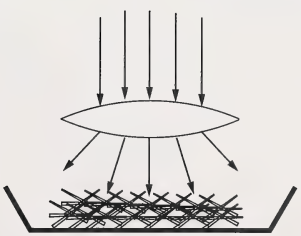
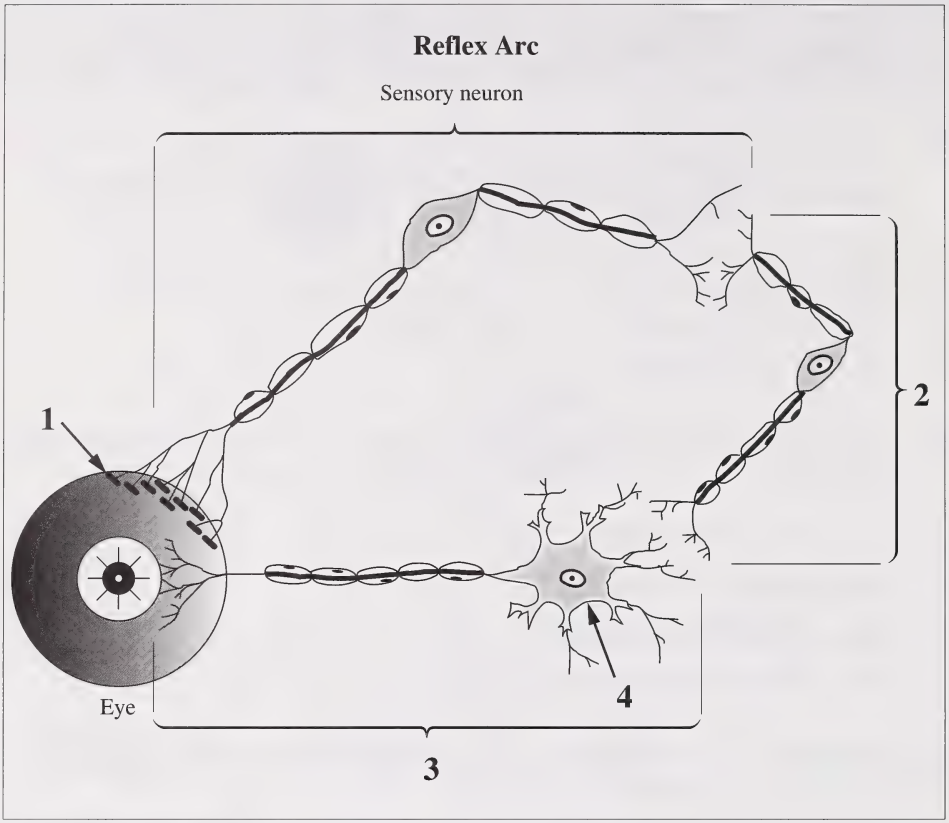


Use the following information to answer the next question.



Numerical Response

8. When the campers removed their sunglasses, their pupils constricted. This is called the pupillary reflex. Match the appropriate number with the corresponding structure of the reflex arc.

Interneuron (association neuron)	_____	(Record in column 1 on the answer sheet.)
Receptor	_____	(Record in column 2 on the answer sheet.)
Motor neuron	_____	(Record in column 3 on the answer sheet.)
Cell body	_____	(Record in column 4 on the answer sheet.)

33. The campers took photographs of their campsite. Different light intensities require an adjustment to the aperture of a camera. The part of the eye that performs the same function as the aperture of a camera is the

A. iris
B. lens
C. retina
D. cornea

Use the following information to answer the next question.

One of the campers developed a blister, which became infected.

Body Responses

1 B cells produce antibodies
2 macrophage produces antigen marker
3 helper T cell identifies marker
4 antibodies attach to foreign protein

Numerical Response

9. What is the correct sequence of body responses to the infection?
Answer: _____ , _____ , _____ , _____

(Record all four digits on the answer sheet.)

---

34. Physical barriers that prevent entry of disease-causing agents into the body are

A. skin and mucous
B. antigens and skin
C. skin and antibodies
D. mucous and antibodies

35. A camper observed that a gas lamp flame appeared to be intense blue–white, while wood fire flames were orange–red. He concluded that the gas-burning lamp had a

A. lower temperature because the light had a longer wavelength
B. lower temperature because the light had a shorter wavelength
C. higher temperature because the light had a longer wavelength
D. higher temperature because the light had a shorter wavelength

Use the following information to answer the next two questions.

The campers used an electric lantern that had a 2.35 A current flowing through it. The lantern was powered by a 6.00 V battery.

Numerical Response

10. The resistance of the lamp is _____ Ω.

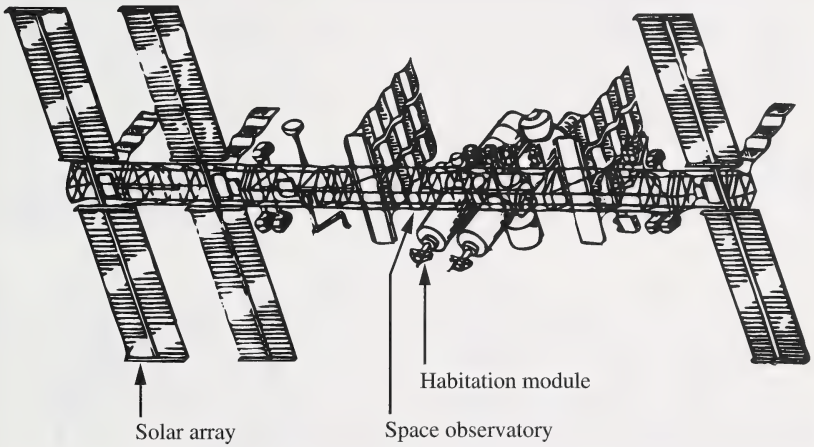
(Round and record your answer to three digits on the answer sheet.)

Numerical Response

11. The power consumption of the lantern is _____ W.

(Round and record your answer to three digits on the answer sheet.)

Information gathered by space satellites is rapidly increasing our understanding of the universe. In the near future, a space station could add to this knowledge.



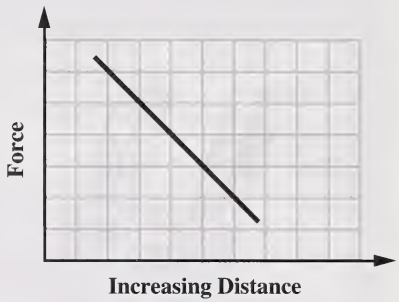
36. Some scientists have proposed the construction of an orbiting space station with large solar collectors. The energy from these collectors would be concentrated and beamed to a receiving station on Earth. In the future, this may be necessary because of the

A. rapid growth of global energy consumption
B. expected ease of establishing space stations
C. decreasing emphasis on sustainable development
D. decreasing concern over maintaining a viable biosphere

37. Such a space station would be positioned in orbit based on its interaction with Earth's gravitational field. Which graph depicts the relationship of the distance between two objects and the gravitational force exerted on one of the objects by the other object?

A.

B.



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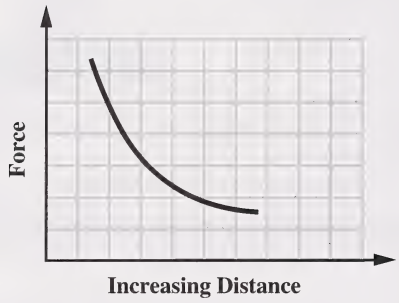


D.

Numerical Response

12. A space station could communicate with Earth using microwave electromagnetic radiation that has a frequency of 4.46×10^9 Hz. The wavelength of this radiation is _____ $\times 10^{-2}$ m.

(Round and record your answer to three digits on the answer sheet.)

38. If a space station were located 3.77×10^8 m from the surface of Earth, how long would it take for a microwave signal to reach Earth?

A. 0.796 s

B. 1.26 s

C. 77.0 s

D. 6.80×10^8 s

39. Electromagnetic radiation in a microwave band has the same properties as light, except that microwaves are not

A. as fast
B. visible
C. reflectable
D. refractable

Use the following information to answer the next question.

The types of electromagnetic radiation listed below approach a station from space.

I red light
II ultraviolet radiation
III radio waves
IV blue light

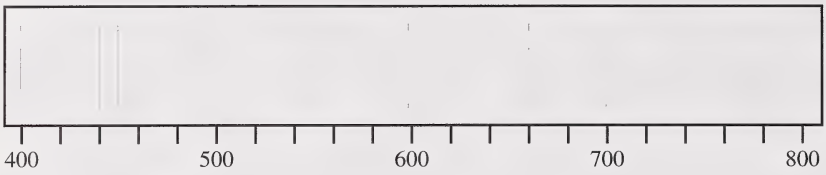
40. When arranged in order from **least** energetic wavelength to **most** energetic wavelength, the types of electromagnetic radiation are

A. I, II, III, IV
B. III, IV, II, I
C. III, I, IV, II
D. IV, II, I, III

Use the following information to answer the next question.

A spectroscope aboard a satellite is used to analyze the composition of a distant star. The spectrum from the star is compared to a list of expected spectral lines.

Spectrum of Star



Expected Spectral Lines

Element	*Four Principal Spectral Lines (nm)*
W	410, 430, 490, 660
X	460, 470, 575, 800
Y	420, 440, 450, 550
Z	400, 580, 600, 700

41. Based on the data, the elements found in the star are

A. X, Y, and Z only
B. W, Y, and Z only
C. W, X, and Z only
D. W, X, and Y only

---

42. A space station would be a better place from which to observe the spectra of stars than would Earth because Earth's atmosphere

A. emits certain frequencies
B. absorbs certain frequencies
C. shifts the frequencies because of winds
D. shifts the frequencies because of Earth's rotation

43. Which aspect of the spectra of stars has provided the main evidence for the "Big Bang" theory for the origin of the universe?

A. Red shift
B. Blue shift
C. Energy distribution
D. Estimation of energy

44. The Sun loses four million tons of mass every second. The **best** explanation for this loss is that as reactions occur in the Sun,

A. some matter is converted to energy
B. the helium that is produced is less dense
C. radioactive decay produces light isotopes
D. the combustion products are low-density gases

The written-response questions follow on page 31.

Written Response – 15% (12 marks)

1. Biologists have noticed that marine animals that are high on the food pyramid, such as dolphins, sea lions, and seals, often suffer from disease epidemics if they live in a highly polluted area. A procedure that was used to study this phenomenon is outlined below.

Procedure:

- Twenty-four harbour seals were divided into two equal groups.
- Group 1 consisted of 12 seals that were fed fish from an area with low pollution levels (Atlantic Ocean).
- Group 2 consisted of 12 seals that were fed fish from an area with high pollution levels (Baltic Sea). The fish from the Baltic Sea contained about ten times the level of organochlorides (substances such as dioxins and furans) than the fish from the Atlantic Ocean.
- Body mass and levels of white cells in the blood were monitored in both groups of seals for approximately two years. The ability of cytotoxic (killer) T cells to function properly was also measured during this time.

a. Provide a problem statement and a hypothesis that are consistent with this study.

Problem:

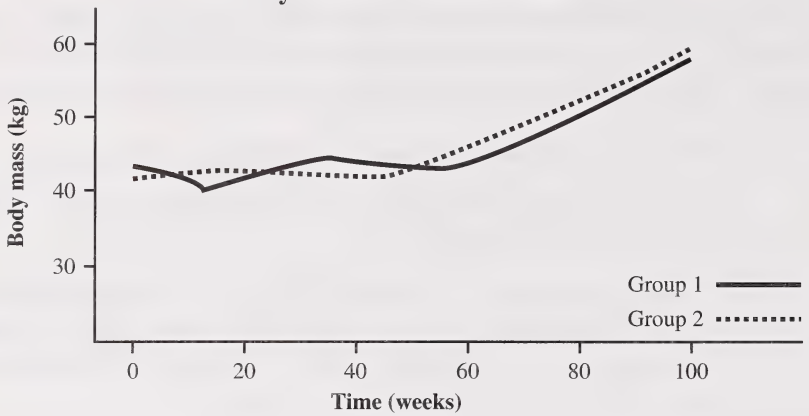
Hypothesis:

b. A description of the conditions that were held constant by the experimenters is not included in the procedure. Outline the variables that you think should be controlled (fixed).

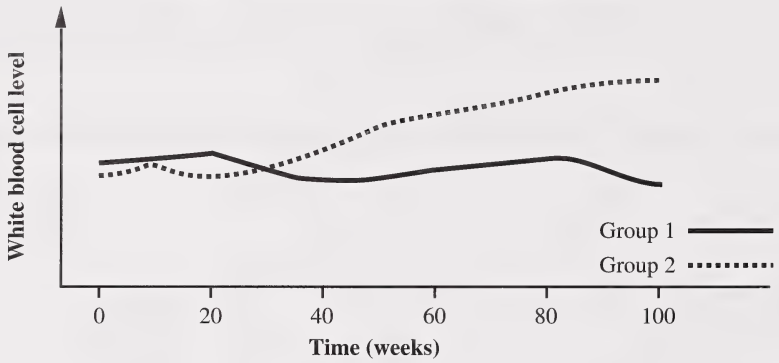
Continued

Use the following graphs to answer part c (next page).

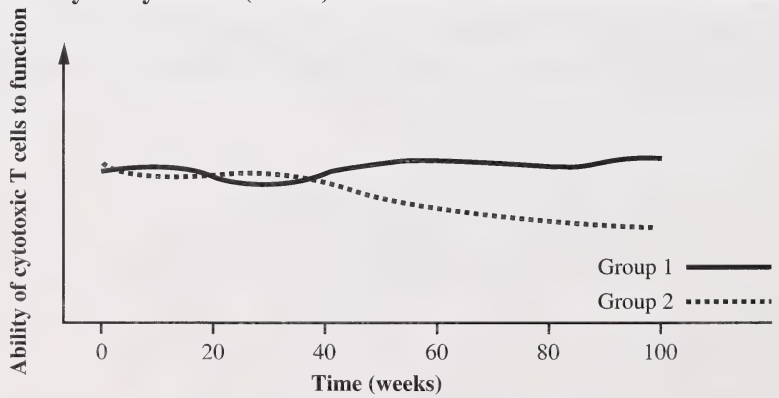
Body Mass of Harbour Seals



White Blood Cell Count of Harbour Seals



Ability of Cytotoxic (Killer) T Cells to Function in Harbour Seals



Continued

c. Interpret the results of the study shown by the graphs. Since the interpretation of data may vary from person to person, it is important to provide clear reasons for your interpretations. Your interpretations should relate to the problem and hypothesis that you provided in **part a**. Your interpretations should go beyond a summary of the data and should provide possible explanations for the results.

Continued

Written Response – 15% (12 marks)

2. Production of electrical power often causes environmental damage. Consider two methods for generating electricity: one that uses a **renewable** energy source and one that uses a **non-renewable** energy source. Describe the environmental and economic impact (risk/benefit analysis) of each method. Use detailed scientific and technological descriptions, including chemical equations if applicable, to clarify your descriptions.

Continued

You have now completed the examination.
If you have time, you may wish to check your answers.

No marks will be given for work done on this page.

Fold and tear along perforation.

No marks will be given for work done on this page.

Fold and tear along perforation.

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